# Northern rock sole (*Lepidopsetta polyxystra*)*

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## Biology

Northern rock sole (*Lepidopsetta polyxystra*) is a flatfish species commonly encountered in the eastern Bering Sea. Its range extends from Puget Sound, Washington, through the Bering Sea and Aleutian Islands to the Kuril Islands. This species is distinguished from its congener, the southern rock sole (*L. bilineata*), through comparison of gillraker and supraorbital pore counts (Orr and Matarese, 2000).

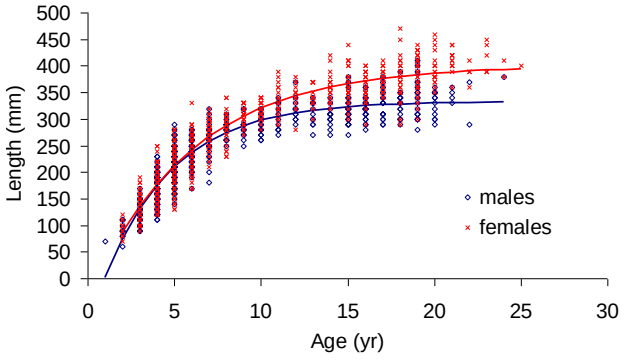


**Figure 1**
Length-at-age data fit with von Bertalanffy growth functions for male (*n*=612) and female (*n*=793) northern rock sole collected during trawl surveys in the Bering Sea and Aleutian Islands 2005-2007.

Flatfish stocks in the waters of the eastern Bering Sea's continental shelf have dramatically increased in abundance since the 1970s, and in particular, northern rock sole stock biomass increased 15-fold between 1975 and 1994 (Walters and Wilderbuer, 2000). This species is a valuable target of trawl fisheries in the Bering Sea, especially the roe fishery, with an average annual catch of 48,175 metric tons between 1989 and 2005 (Wilderbuer and Nichol, 2006).

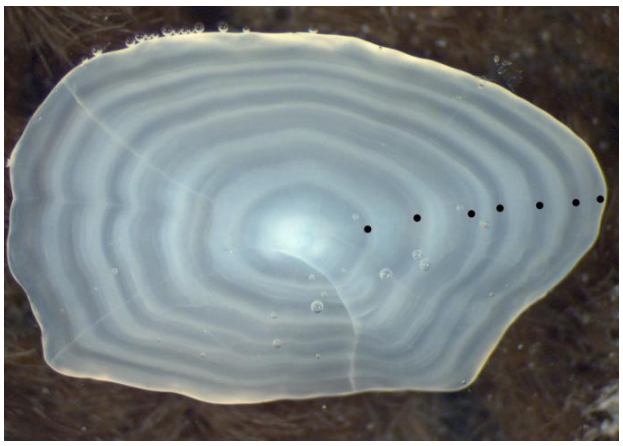

**Figure 2**
Northern rock sole otolith with a clear surface growth pattern. Age estimate is 7 years. Viewed with reflected light.

Northern rock sole spawn in winter through spring, producing demersal egg masses that adhere to benthic substrates (Stark and Somerton, 2002). Larvae are pelagic and are most commonly found over depths of less than 500 m (Orr and Matarese, 2000). Adults have

**Table 1**
Age and length estimates (minimum, maximum, and average), otolith preparation method (SU: surface; BB: break-and-burn), and precision estimates (Agree: percent agreement; CV: coefficient of variation; APE: average percent error) for northern rock sole aged by the AFSC Age and Growth Program. Data shown by year collected.

| | | AGE (yr) | | | LENGTH (mm) | | | METHOD (%) | | PRECISION (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year collected | *n* | Min | Max | Ave | Min | Max | Ave | SU | BB | Agree | CV | APE |
| 2007 | 1253 | 1 | 25 | 11 | 70 | 570 | 287 | 24 | 76 | 63 | 3.3 | 2.4 |
| 2006 | 1230 | 2 | 28 | 11 | 60 | 490 | 279 | 20 | 80 | 77 | 1.9 | 1.3 |
| 2005 | 910 | 2 | 23 | 10 | 90 | 450 | 259 | 28 | 72 | 57 | 4.6 | 3.2 |
| 2004 | 931 | 2 | 27 | 11 | 80 | 450 | 255 | 7 | 93 | 57 | 4.1 | 2.9 |
| 2003 | 1128 | 1 | 27 | 11 | 60 | 440 | 252 | 22 | 78 | 71 | 2.6 | 1.9 |
| 2002 | 1021 | 1 | 23 | 11 | 60 | 460 | 260 | 20 | 80 | 76 | 1.7 | 1.2 |
| 2001 | 933 | 2 | 21 | 11 | 90 | 440 | 280 | 11 | 89 | 65 | 2.3 | 1.6 |
| 2000 | 984 | 3 | 27 | 12 | 120 | 460 | 295 | 5 | 95 | 67 | 2.7 | 1.9 |
| 1999 | 1261 | 2 | 23 | 10 | 90 | 530 | 275 | 9 | 91 | 72 | 2.9 | 2.1 |
| 1998 | 995 | 2 | 24 | 11 | 90 | 450 | 268 | 12 | 88 | 64 | 2.9 | 2.1 |
| 1996 | 266 | 1 | 21 | 6 | 150 | 480 | 328 | 19 | 81 | 92 | 1.0 | 0.7 |

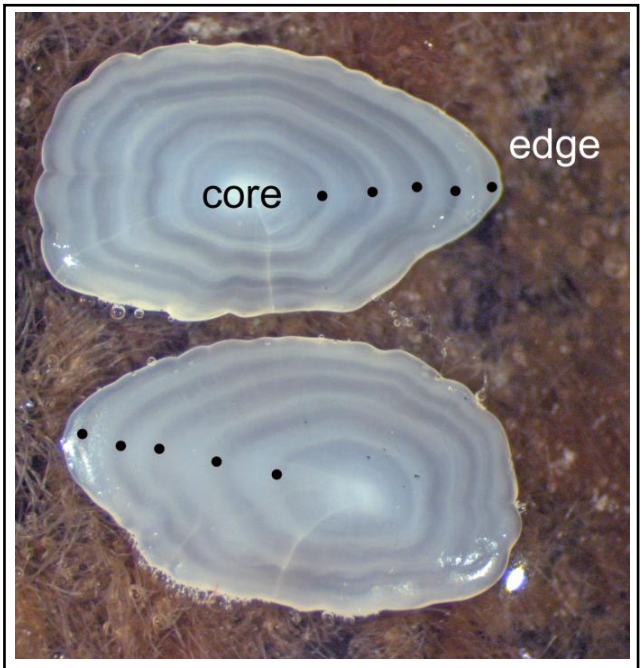


**Figure 3**
Northern rock sole otolith with a clear surface growth pattern. Age estimate is 5 years. Viewed with reflected light.

separate winter spawning and summer feeding distributions (Wilderbuer and Nichol, 2006). Females reach 50% maturity at 328 mm, or about 7 years of age (Stark and Somerton, 2002). Males and females exhibit significant differences in growth, with females generally growing more slowly but to larger sizes than males (Stark and Somerton, 2002). Von Bertalanffy growth parameters for northern rock sole collected during trawl surveys in the Bering Sea and Aleutian Islands from 2005-2007 were $L_{\infty}$=333.1 mm, k=0.2474/yr, and $t_0$=0.984 yr for males and $L_{\infty}$=400.7 mm, k=0.1704/yr, and $t_0$=0.590 yr for females (Fig. 1).

## Age determination history

*Lepidopsetta* species have been aged on a production basis at the Alaska Fisheries Science Center (AFSC) since 1971, although age records have only distinguished between northern and southern rock sole since 1996; prior to that time they were believed to be a single species. Otoliths are aged primarily using the break-and-burn method, although surface readings are made when possible (Table 1). (Please see Goetz et al., 2012, for a more detailed description of standard AFSC otolith preparation methods.)

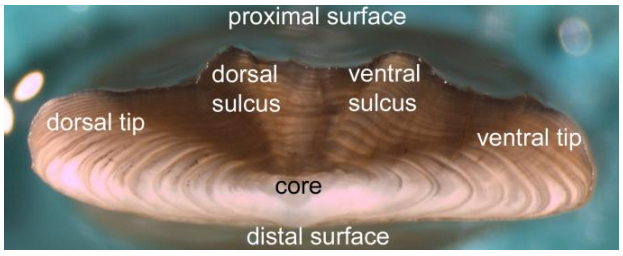


**Figure 4**
Break-and-burn cross section demonstrating the reading axes used to determine age in northern rock sole otoliths. Viewed with reflected light.

Age determination of northern rock sole is relatively simple, and inter-reader agreement tends to be high (Table 1). The maximum age reported by the AFSC Age and Growth Program for northern rock sole is 28 years (Table 1). Age estimates for this species have been corroborated by edge analysis (Kimura et al., 2007) and synchronous growth patterns shared among individuals (Matta et al., 2010).

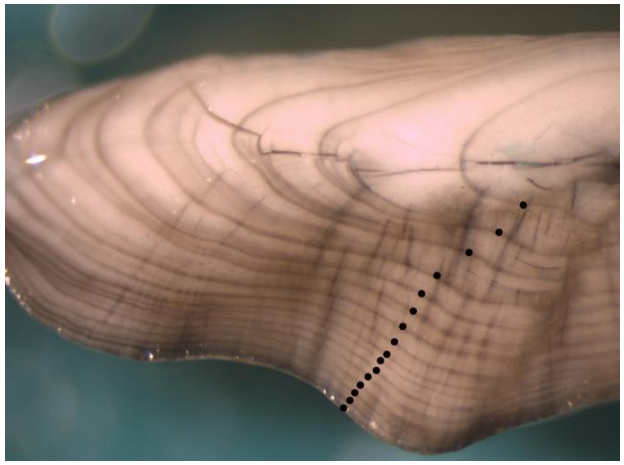

**Figure 5**
Clear northern rock sole otolith break-and-burn pattern. Age estimate is 16 years. Viewed with reflected light.

## Current age determination methods

For young fish (<8 years) it is sometimes possible to determine age solely from the otolith surface (Fig. 2). The otolith is read from the core to the edge under a dissecting microscope with reflected light from a fiber optic light source (Fig. 3). Each year of growth typically consists of one opaque (light) and one translucent (dark) growth zone. In general, each translucent growth zone is equivalent to an annual mark and should be counted if it extends around the circumference of the otolith. Surface examination should only be attempted by experienced age readers when the growth pattern is clear.

For older fish and otoliths with vague surface patterns, the break-and-burn technique is necessary. Starting at the core, each translucent growth zone is counted reading out toward the edge. It is best to examine multiple reading axes to obtain a precise age estimate (Fig. 4). If age estimates differ among reading axes, the final age estimate is assigned using the clearest axis.


**Figure 6**
Relatively clear northern rock sole otolith break-and-burn pattern. Splitting in years 6, 8, and 9. Age estimate is 19 years. Viewed with reflected light.

Translucent growth zones should only be counted if they extend around the circumference of the otolith (Fig. 5). Checks are sometimes present and can usually be distinguished from annual marks, as they are fainter and do not extend around the entire circumference of the otolith. Occasionally splitting, where a single annual mark is made up of two or more translucent growth zones, also occurs. Split growth zones can be identified in much the same way as checks, as they typically do not extend around the circumference of the otolith (Fig. 6). Some northern rock sole otoliths also have constricted (i.e., closely spaced) annual marks (Fig. 7).

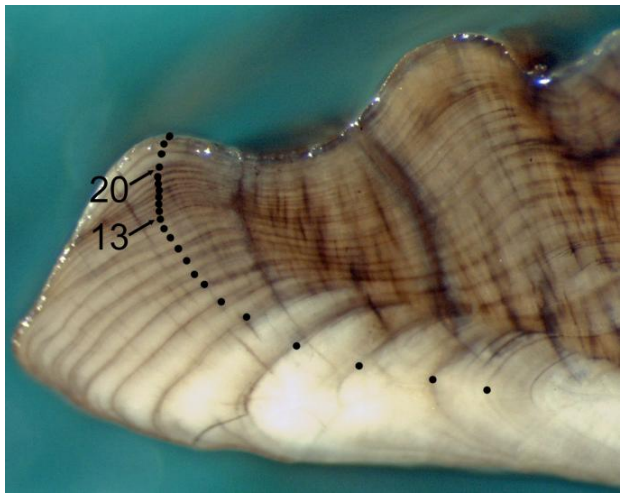


**Figure 7**
Difficult growth pattern in a northern rock sole otolith break-and-burn cross section. Constricted annual marks (years 13-20). Age estimate is 23 years. Viewed with reflected light.

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